Learning By A. C. Catania

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From the behavioristic perspective, teaching may be defined as the practice of arranging contingencies of reinforcement that expedite the acquisition of changes in behavior (Skinner, 1968). A contingency of reinforcement, of course, involves the interrelations among a discriminative stimulus that sets the occasion for a response, the response itself, and the reinforcing consequence achieved by the response. The role of a textbook is therefore that of the discriminative stimulus, that is, of presenting material that sets the occasion for the kinds of responses that are to be acquired. Students make the responses, and the instructors administer the differential reinforcement.

Now, textbooks may present material on several different levels, and, accordingly, may set the occasion for several different levels of responses (Bloom, 1956). Presumably, every adequate psychology textbook presents material regarding what psychologists do. Only the exceptional textbook presents material in such a way that students acquire general analytical skills by which they may make sense out of behavioral events. In this regard, we are fortunate to have an important new textbook dealing with the analysis of behavior, *Learning* by A. Charles Catania.

Catania's textbook is important not only because it presents a wealth of material regarding what psychologists do, but also because it presents material relating to behaviorism as a general analytical system by which behavioral events may be understood. Behaviorism, of course, is not simply the scientific study of behavior, but rather an entire philosophy of science, concerned with the subject matter, methods, and dimensions of psychology. Behaviorists treat behavior as a subject matter in its own right, at a single level of observation, as a dependent variable in a functional relation. Thus, a central theme of the text is that psychology is concerned with behavior, not with the development of a supposed inner system of which observed, measured behavior is a mere indicant. The author recognizes, however, that some experimental psychologists feel that the study of observable, measurable behavior is useful only to the extent that it provides evidence of things going on somewhere else, at some other level or dimension, which must be described in different terms. Catania does not reject their data out of hand, but rather argues that the data must be reformulated, so as to be consistent with the basic tenets of natural science. This orientation constitutes behaviorism at work, and Catania admirably displays this orientation in his textbook. Indeed, one might even be comfortable with a subtitle: *Learning, or how a behaviorist makes sense out of the data from conditioning and learning, with frequent reference to experimental psychology in general.*

Overview of the Text

The book consists of 15 chapters, each of which is about 25 pages long. If I may borrow heavily from the Preface, the book is organized into two major sections. The first section, consisting of chapters 2 through 9, deals with basic topics from experiments where the subjects have been lower animals. Traditionally, these topics are subsumed under a heading of animal conditioning and learning. The second section, consisting

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of chapters 10 through 14, deals with basic topics from experiments where the subjects have been humans. Traditionally, these topics have been subsumed under a heading of human learning and memory. Unfortunately, the field of experimental psychology, and especially the field of learning within experimental psychology, has evolved in such a way that human learning and animal learning have every appearance of being mutually exclusive. Catania's presentation of the material is such that if people do consider the two fields as mutually exclusive, they do so because they themselves impose such a dichotomy, rather than because the subject matter of the two fields must be dealt with in mutually exclusive ways. Catania shows that the important terms and concepts of psychology pertain to an analysis of the behavior of organisms, whether the organisms are lower animals or humans, and whether the behavior is lever pressing, key pecking, or recalling lists of nonsense syllables.

Chapters 2 through 10 of the text are undoubtedly the ones that will be of most interest to the present audience. Chapter 2 systematically presents a conceptual framework for differentiating operant behavior from respondent behavior. The material in this chapter resembles material that the author has published elsewhere (Catania, 1971, 1973). Of particular value are the distinctions cast in terms of three operations: (a) stimulus presentation operations, (b) consequential operations, and (c) stimulus control operations. Operation (a) is involved in respondent behavior, and when conjoined with operation (c), in respondent conditioning. Operation (b) is involved in operant behavior, and when conjoined with operation (c), in discriminated operant behavior. These distinctions are important because they show that a response is identified by the relations among the independent variables that produce the response, rather than by some topographical property.

In the Preface, Catania indicates that the material is organized in such a way that the chapters and topics may be taken pretty much in the order presented. Having used the text in an upper division course, I have found it somewhat easier to skip Chapter 3, concerning elicitation and reflexes, and take up Chapters 4 and 6 after Chapter 2. Chapter 4 concerns reinforcing consequences. In no other text will the reader find a more systematic treatment of the vocabulary of reinforcement than in this chapter. Chapter 6 concerns the development of operants. Some of this material, e.g., that concerning differential reinforcement of response classes, comes from Catania (1973), and is just as valuable here as it was then.

If an instructor wanted to continue with the topic of reinforcement, Chapter 8 might be taken up next. The first two-thirds of this 30 page chapter deals with basic schedules: FI, FR, VI, VR. The treatment here is sound, as one would expect. Of particular interest is the analysis of reinforcement schedules and causality, assessed by a review of data from experiments involving delayed and response-independent reinforcers. Those familiar with the author's research career will recognize this matter as one that has engaged his interest in recent years. So far as I know, no other text includes a comparable section. The remaining one-third of the chapter deals with schedule combinations: multiple schedules, chain schedules, and concurrent schedules. I confess a special interest in choice, observing, and conditioned reinforcement, and naturally I would have enjoyed more coverage here. For example, conditioned reinforcement is included only in the context of chain schedules, and no mention is made of recent work using the observing response. The many uses of the term "information" in experimental psychology would have made a nice illustration showing how a behaviorist provides an operational analysis of important concepts in psychological science.

If an instructor wanted to consider further the matter of how consequences affect behavior, the instructor might next take up Chapter 5, on aversive control. The definitional treatments of punishment and negative reinforcement here are thorough. Punishment is considered first in the chapter, and although the coverage is sound, it is not exceptionally detailed:

> For example, the following are some conclusions based on experiments with electric shock as a punisher of a pigeon's food reinforced key pecking: the more intense and immediate the punisher, the more effective it will be; a punisher introduced at its maximum intensity will suppress responding more effectively than a punisher introduced at low intensity and gradually increased to a maximum intensity; and the effectiveness of the punisher may change over extended periods of punishment, as when a punisher of low intensity gradually becomes ineffective after many presentations (cf., Azrin and Holz, 1966, pp. 427-27) (Catania, 1979, p. 97).

These statements are, of course, accurate, but I found it useful to elaborate in order to help students move from intraverbals to tacts derived from the analysis of results.

Escape and avoidance are then combined in the second section of the chapter. The treatment of discriminated avoidance, the stimulus for which becomes exceedingly important when one addresses two factor theory, is unfortunately somewhat limited. Molar and molecular orientations to the analysis of behavior are included at this point, and in a most interesting way:

> Thus, there seems to be no priori justification for assuming that an organism whose responding is determined by the molecular properties of one situation (e.g., the consistent temporal relations between responding and shocks established by the RS and SS intervals of Sidman avoidance) would be incapable of responding to molar properties of another situation (e.g., the consistent overall relations between rate of responding and rate of shock established by a probabilistic avoidance schedule). If this is so, it is not a matter of choosing one or the other approach but rather of deciding which approach is more appropriate to the analysis of any given situation (Catania, 1979, p. 112).

The reader is encouraged to compare and contrast this point of view with that of, say, Rachlin (1975), who maintains a steadfastly molar orientation to the analysis of behavior.

Chapter 7 takes up the topic of stimulus control. Reynolds (1961) is by now an almost obligatory reference when talking about attention, but the attempts to replicate this study might also have been mentioned (e.g., Wilkie and Masson, 1976). Gradients are discussed, although more could be included here on factors influencing the shape of gradients, such as schedule used during training, deprivation, drug effects, and prior training history.

Somewhat more conventional animal discrimination learning procedures are also included in Chapter 7. Given special attention are matching to sample, concept learning, and learning sets. If an instructor wanted to delve more deeply into these or other procedures, these issues could be taken up at this point with little difficulty. In any case, the book effectively makes the point that the procedures produce behavior that is to be dealt with in terms of contingencies of reinforcement, and not in terms of supposed cognitive processes responsible for the behavior.

The material reviewed thus far has concerned the determiners of operant behavior. As mentioned earlier, Chapter 3 addresses the reflex and elicited behavior. Since Chapter 9 specifically concerns respondent conditioning, the two chapters could well go together. The re-birth of interest in respondent conditioning in the last 10 years has had a number of effects on the field, and many interesting data have been generated using the respondent conditioning paradigm. Professor Catania's treatment here is balanced, although not extensive.

For example, Kamin's (1969) blocking effect is probably one of the two or three most influential effects in the last 15 years in animal conditioning and learning. It was conspicuously absent in Nevin and Reynolds (1973), but it did receive good treatment in Rachlin (1975). Rescorla and Wagner's (1972) attempt to codify these effects into a mathematical model was also included in Rachlin (1975). These two

matters are reference in Catania's book, but my feeling is that they should be dealt with more extensively. A student in the analysis of behavior should know what they are, not necessarily because they constitute an advance in the experimental analysis of behavior, but because they are such influential topics on the contemporary scene.

Autoshaping and automaintenance are also covered in chapter 9. The perspective from which the section is written is quite interesting: "The production and maintenance of keypecking in autoshaping and automaintenance has the critical features that define respondent conditioning . . . Perhaps then the behavioral relations that occur in autoshaping are prototypes of the processes from which operant behavior evolves" (p. 213-214). The treatment they receive in the section is balanced and insightful, which is important, because autoshaping in recent years has been considered a challenge to the theoretical distinction between operant and respondent behavior. Catania's treatment of autoshaping, showing that it need not be so considered, emphasizes the multiple functions of a stimulus, in particular, of food that may function as both a reinforcing stimulus as an eliciting stimulus. To be sure, a given stimulus only rarely serves one role with respect to an organism's behavior, and an understanding of the interaction between respondent behavior and operant behavior can only be considered an important step forward in the analysis of behavior.

Chapter 10 deals with a functional analysis of verbal behavior. Included is review and discussion of Skinner's (1957) functional classes of verbal behavior: mands, tacts, echoics, transcription, textuals, and intraverbals. Autoclitic processes are also covered, with a brief mention of the relation between autoclitics and the traditional issues of grammar and syntax. The chapter also includes two-thirds of a page on tacts of private events. Since the treatment of private events is one of the most significant features of behaviorism, I feel that this section would benefit from supplemental coverage, specifically on the differences between behaviorism and traditional psychology. Additional material on knowledge and explanation from a behavioristic perspective would top off this section nicely.

Evaluation

As mentioned earlier, I found it useful to depart from the intended sequence of topics in the book. The text permits the instructor to do this, of course, but I would like to provide a concrete example of why an instructor might want to alter the sequence of topics. Consider two important roles that VI schedules play in the experimental analysis of behavior: (a) they generate baselines with respect to which many punishment effects are assessed, and (b) they are used extensively in stimulus generalization research. Variable-interval schedules are taken up in Chapter 8, and there is no question that the coverage here is sound. However, punishment effects are discussed in Chapter 5. It may be difficult to talk about the importance of analyzing the full context in which behavior occurs, in this case, the superimposing of the punishment operation upon responding maintained by a VI schedule of positive reinforcement, when the student is not yet aware of a VI schedule. This matter becomes even more important when one compares the effects of punishment on responding maintained by VI and FR schedules of positive reinforcement. Similarly, stimulus generalization is taken up in Chapter 7. A reference to Guttman and Kalish (1956), a central experiment in the history of stimulus control, is absent in favor of a reference to Jenkins and Harrison (1960). In any case, the role of VI schedules in the study of generalization gradients is not mentioned, although there is brief mention that the schedule used in training does affect the shape of the gradient (p. 147). Again, students might

learn more about stimulus generalization if they know about VI schedules before they start Chapter 7.

Depending upon the kind of course an instructor wants to teach, an instructor might also provide the theoretical background for certain experiments in somewhat greater detail than does the book. I see no problem in not devoting major portions of the book to Pavlov, Thorndike, Watson, Guthrie, Tolman, Skinner, Hull, et al. The book is not intended as a historical review of learning theory in that sense. However, many experiments discussed in the book were performed in connection with theories and often the coverage of the background is limited. For example, latent learning experiments examined the role of reinforcement in "learning," many avoidance studies have investigated two process theory, countless experiments have dealt with whether differential reinforcement was necessary to get a peaked generalization gradient, and so on. Much of this background is not included. If the meaning of behavior is to be found in the determiners of behavior, then at least part of the meaning of certain experiments—and to perform an experiment is certainly to engage in behavior—is to be found in the theoretical context in which the experiment is embedded. Thus, if an instructor wants to convey the meaning of certain important experiments mentioned in the book, the instructor should be prepared to establish the appropriate theoretical context out of which the experiment springs.

Perhaps the strongest feature of the text is its treatment of the language of psychology. Catania sets the stage for his treatment of language at the bottom of the first page in Chapter 1: "In our study of learning, we must remember to distinguish between two different problems: first, what is the nature of the phenomena or events we speak of as learning, and second, what is the best way of talking about them?" (p. 3). Many of the important sections of chapters begin with comprehensive analyses of the vocabulary and grammar of the important terms, e.g., the vocabulary of reinforcement and punishment, and grammatical comparisons among positive reinforcement, negative reinforcement, and punishment. Possibly the only addition by which the book would benefit in this area is a glossary comparable to Catania (1969). In any case, Catania's clear and consistent adherence to behavioral usage sets a standard for all to follow.

Of course, any comments with respect to Catania's precise use of language are made at some personal risk. In describing Kohler's problem solving experiments with chimpanzees, Catania apparently can't resist noting that the unsuccessful attempts to solve the problems might aptly be characterized as "fruitless." One fully expects him doggedly describing the work of Pavlov, though perhaps he would be more sheepish when dealing with Liddell.

In closing, I would like to address a very fundamental issue in the analysis of behavior, the issue of reinforcement, and how reinforcement is dealt with in the text. Almost all important questions in psychology can be reduced to questions about the causes of behavior. The behaviorist finds that the answer to the question of the causes of behavior lies in the specification of the prevailing contingency of reinforcement, that is, in the specification of the interrelations among the antecedent discriminative stimuli, responses, and reinforcing consequences. Now, one question that almost always arises in connection with the causal explanation of behavior is whether reinforcement is circular.

> When a response becomes more probable because it has produced a stimulus, we say that the response has been reinforced, and we call the stimulus a reinforcer. If asked how we know that the stimulus was a reinforcer, we can point to the increase in responding. If then asked why the increase occurred, we may say that it did so because the response was reinforced. At some point, we begin to repeat ourselves. Once we define a reinforcer by its effect on behavior, we create a problem of circular

definition if we simultaneously define the effect by the reinforcing stimulus.

One solution is to recognize that the term reinforcement is descriptive rather than explanatory. It names a particular relation between responses and the environment, but it does not explain that relation (Catania, 1979, p. 75).

At issue here, of course, is the nature and status of description with respect to the nature and status of explanation.

As in other sciences, one must guard in psychology against the Formalistic Fallacy, according to which the name or description of some process is taken as the cause of the process, and it is thereby assumed that the process has been explained (cf., Moore, 1975, 123, 135 ff.). Thus, what Catania cautions us against is reifying the term reinforcement, lest we view the term as referring to a "thing" that possesses the power to cause behavior. To so view the term is circular, because the term reinforcement simply identifies that responding has increased in frequency.

The issue can perhaps be made clearer if we consider that two main questions are involved in a discussion of reinforcement and circularity. The first question might be stated as follows: "Why did responding increase?" The second might be stated, "Why do we call the stimulus that is produced by the response a reinforcer?" Indeed, the first of these questions may be broken down even further, into three separate subquestions.

The first subquestion might be phrased as, "Why do we *say* that responding increases?" In this sense, the question inquires about the stimulus control over the tact "increases." Presumably, one uses "increases" in connection with the comparison of numbers on a counter. The second subquestion asks, "In what ways is the increase in responding related to environmental circumstances?" In this sense, a simple operational analysis will determine, for example, whether the probability of responding is greater when the responding produces some consequence as compared with when it does not. The third subquestion asks, "Why does the consequence have the effect it does, namely, of increasing the probability of responding?" In this sense, the question inquires into the physiological or genetic structure of the organism. Organisms that are not sensitive to the consequences of their responses are not likely to survive. Susceptibility to influence from environmental stimuli, of which a reinforcing consequence is surely one sort, is a characteristic of a behaving organism, and as such is presumably inherited. In any case, the question in this third sense is not necessarily a functional question. In this third sense the question will be answered by physiologists, rather than by psychologists, although psychologists will almost certainly give the physiologists some important clues regarding that for which they should look.

To ask the second main question is to ask why we label a stimulus as a reinforcer. This question inquires about the stimulus control over the term "reinforcer." In our language, we use the term reinforcer in connection with certain observed relations between responding its consequences. Catania neatly specified these relations in Chapter 4: (a) the responding must produce the consequence, (b) the responding must increase in probability, and (c) the increase in probability must occur because the responding produced this consequence. The term reinforcer is not used when these criteria are not satisfied.

Thus, we explain behavior by specifying the contingencies of reinforcement that promote the behavior of interest. In part, that does mean specifying the relation between responding and consequences, but it does not mean endowing reinforcement with some sort of mystical potency that connects antecedents, responses, and consequences together. To be sure, specifying that a response does produce some consequence is part of a causal analysis, but to say that reinforcement caused the response is no more meaningful than to say that stimulus con-

trol caused the response. Catania's treatment here is subtle, but one does not go wrong in following his lead.

Conclusion and Summary

Professor Catania's book, *Learning,* deals with a wider variety of important issues than any other single text currently available in the experimental analysis of behavior. The book emphasizes the continuity of behavioral processes, from lower animals to humans, from maze running to lever pressing to paired-associate learning. The book also gives a true picture of what it means to be a behaviorist. It does not do so because it eschews data from runways and mazes in favor of data from operant chambers, or because it considers only intersubjectively verifiable events, but precisely because it does consider data from apparatuses other than operant chambers, and in the case of private events, consider events not themselves verifiable by more than one person. The essential feature of behaviorism, therefore, is its epistemology, not its hardware, and we get an excellent illustration of this epistemology at work in the text. Now, whether any text should be used by an instructor is a way of asking whether that text will help achieve the special reinforcers that come from teaching. Catania's text has for me.

REFERENCES

Bloom, B. S. *A taxonomy of educational objectives.* New York: David Mackay Co., 1956.

Catania, A. C. Glossary. In A. C. Catania (Ed.). *Contemporary research in operant behavior.* Glenview, Ill.: Scott-Foresman, 1968. Pp. 327-349.

Catania, A. C. Elicitation, reinforcement, and stimulus control. In R. Giaser (Ed.), *The nature of reinforcement.* New York: Academic Press, 1971. Pp. 196-220.

Catania, A. C. The nature of learning. In J. A. Nevin and G. S. Reynolds (Eds.), *The study of behavior.* Glenview, Ill.: Scott-Foresman, 1973. Pp. 31-68.

Catania, A. C. *Learning.* Englewood Cliffs: Prentice Hall, 1979.

Guttman, N., and Kalish, H. Discriminability and stimulus generalization. *Journal of Experimental Psychology,* 1965, *51,* 79-88.

Jenkins, H., and Harrison, R. Effect of discrimination training on auditory generalization. *Journal of Experimental Psychology,* 1960, *59,* 246-253.

Kamin, L. Predictability, surprise, attention, and conditioning. In B. A. Campbell and R. M. Church (Eds.), *Punishment and aversive behavior.* New York: Appleton-Century-Crofts, 1969. Pp. 279-296.

Moore, J. On the principle of operationism in a science of behavior. *Behaviorism,* 1975, *3,* 120-138.

Nevin, J. A., and Reynolds, G. S. (Eds.), *The study of behavior.* Glenview, Ill.: Scott-Foresman, 1973.

Rachlin, H. *Behavior and learning.* San Francisco: Freeman, 1975.

Rescorla, R., and Wagner, A. A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A. H. Black and W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory.* New York: Appleton-Century-Crofts, 1972. Pp. 64-99.

Reynolds, G. S. Attention in the pigeon. *Journal of the Experimental Analysis of Behavior,* 1961, *4,* 203-208.

Skinner, B. F. *Verbal behavior.* New York: Appleton-Century-Crofts, 1957.

Skinner, B. F. *The technology of teaching.* New York: Appleton-Century-Crofts, 1968.

Wilkie, D. M., and Masson, M. E. Attention in the pigeon. A reevaluation. *Journal of the Experimental Analysis of Behavior,* 1976, *26,* 207-212.